TTT RCX IR Proximity Detector

Introduction and Warning

The first thing that must be said is that this is a kit. You must assemble it using a soldering iron and a few other common electronic assembly tools. **Because it's a kit, there is no warranty**, but you get all the email support that you can use from me, the creator, because I want you to succeed! Fortunately, I have put several of these kits together in far cruder form than what you are getting and they have all worked without flaw on the first pass. The parts are labeled on the board and I will show you step-by-step how to build the RCX IRPD board and check your work. This is a very small board, it's quite crowded and if you aren't careful you can create solder-bridge shorts, so be careful and use a soldering iron that has a 1/8" (3mm) tip or smaller. A 15-25 Watt iron should be just fine. If you have trouble, you can email me at dlc@verinet.com or check my web page at http://www.verinet.com/~dlc/botlinks.htm for more information.

Tools You Will Need and How to Set Up Your Working Area

Your Work Area

Find a space that is clean and flat and cover it with either an anti-static bag or aluminum foil so that it won't hold a static charge, a wooden surface works quite well too, but make sure that you don't mind solder blobs landing on it, they can discolor a tabletop. Take your shoes off - Really, shoes tend to be rubber soled and will allow you to build up a static charge that can damage several of the components that come in this kit. Remove any wool or polyester sweaters for the same reasons as you removed your shoes. All static sensitive parts in the kit will come stuck in anti-static foam, leave them there until you need them so that they remain so protected. Often times I put all of my parts in a small tin cup or muffin pan to sort them out.

Your Tools

These are the tools that you will need to build the RCX IRPD board.

Soldering iron in the 15-25 Watt range with a 1/8" (3mm) or less spade (flat) tip
Small diagonal cutters
Small needle-nosed pliers
Resin core electronics 60/40 solder
Wire stripper
Scissors

These tools will make life easier on you, or help you recover from mistakes.

"Third Hand" hobby holder. You've seen them, two alligator clips to hold stuff and a magnifier lens.
Solder sucker or solder wick to remove solder
Digital Volt Meter to help make sure voltages are correct and there are no shorts or open circuits. (Radio Shack sells small ones really cheap, I strongly recommend you get one, they have a thousand and one uses!)

Other Parts Needed To Finish Your RCX IRPD

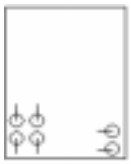
This kit comes with all of the custom pieces needed to build the circuit board. There are two things that *you* need to supply to finish it. You need a power/sensor wire and you need Lego bricks to mount the project into. You can get both together if you get the Lego 9V battery box, LEGO S@H, part #5391.

Building the RCX IRPD Circuit Board

First remove all parts from the bag and put them where you can see and reach them easily. Take the circuit board out and place it such that you can read the printing, this is the component side of the board.
This is the order of installation that works the best. After you install the parts with long leads on them, clip the leads to 1mm in length on the bottom side of the board. To keep the parts from falling out of the board when you turn it over to solder them, simply bend the leads slightly away from each other on the bottom of the board. Use the minimum amount of solder that will completely fill the hole and make sure that the solder forms a cone, a globe means a bad solder joint, reheat the solder until it flows better. You should NEVER have the iron on any lead for more than 2 seconds, 1 second is preferred. If

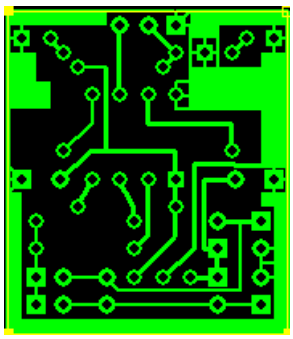
you are worried about damaging your PIC (8 pin chip) then install an 8 pin socket as the first step and put the PIC in after you have finished all other soldering work. Pin 1 of the PIC goes in the square hole, make sure that you have the notch of the socket facing the square hole.

1. Bend the leads of all resistors 90 degrees as close as possible to their labeled locations. The resistors values are read as follows:
   - 10K : Black - Brown - Orange - Gold
   - 4K7 : Yellow - Purple - Red - Gold
   - 2K2 : Red - Red - Red - Gold
   - 47 : Yellow - Purple - Black - Gold
2. Install the .1uf cap into the holes noted by ".1" and one 47uf cap in the center left side of the board. The 47uf caps have one lead shorter than the other, this lead usually has a "-" printed in a band on the cap as well, the "-" (negative) lead goes into the square hole on the PC board. The .1uf cap is the little yellow thing.
3. Install all the 1N4148 diodes. The banded side of the diode always goes into the square hole. These must be installed "standing up" as opposed to "laying down" like the resistors were. Explaining how to do this is too complex, so here's a picture of how to bend the leads and which end of the diode is next to the PC board. Make **sure** the banded side of the diode goes into the square hole in all cases!



4. Install the IR Detector module. This is the small metal can. Obviously, it is installed such that the colored window faces away from the board.
5. Install the 47uf cap that is near the IR Detector module, it's a tight fit, again, the "-" (short lead) goes into the square hole there.
6. Install the two IR LED's. The LED's have a short lead that is on the flattened side of the LED's plastic case. This short lead goes into, you guessed it, the square hole. Install the LED such that over half of the LED is past the top of the IR Detector. Now carefully bend the wires of the LED's so that they face forward at about the same height as the lens on the IR Detector. The leads should be either straight out of the PC board or bent slightly back towards the PC board.
7. Install the PIC controller. Place the chip such that when the writing on the chip is correct to read it, that the lower left corner of the chip is in the square hole. This is noted on the chip with a "+" in the lower left.
8. Install the 78L05(2930) regulator. The flat side of this part must face the center of the board. The curved side is to the edge of the board. Install this so that it does not stand any taller than the IR Detector housing.
9. Finally, install the power/sensor wires to the board. There will be two holes with nothing in them in the lower, right of center of the PC board. Cut your connector wire such that you have 4 1/2" (11.5cm) of wire from the connector plate. Using your diagonal cutters, snip carefully between the two wires back about 1/2" (1.5cm). Trim 3/16" (4mm) of insulation off of each wire and using your fingers, twist the wire strands of each side in a circle to make a very smooth and regular wire column. Tin these bare wires with a very small amount of solder so that they are stiff. Insert them into the two holes and solder them. This will take practice, the holes are small and you can't use much solder! Trim to fit. If you went with the 9V battery box idea, just solder one wire from each hole to each conductor on the connector plate.

Checking Your Work and Troubleshooting Problems



If you were very careful and didn't use too much solder then your board is now ready to use. But, you want to be careful so here are the places to check for problems. The parts are very close together and the traces run close to the pads. Use this image to make sure you haven't shorted any traces. Using a DVM (You did get one didn't you?) you can check the traces by putting the DVM into "Ohms" or resistance mode and selecting the 10 ohm range. Make sure that you don't get a very low reading between traces or pads that aren't supposed to be connected, the correct readings should be "infinity" as defined by your DVM's manual. Sometimes you can get readings of 5-10 ohms around diodes, reverse the leads and the reading should go to infinity. A short will show up as .002 or something like that, anything else isn't a short. If you do find a short, simply reheat the joint and wick some of the solder away. Make sure that all of your parts are installed correctly, go back and re-read the instructions and check your work.

Tuning and Using Your RCX IRPD

Now that you have it built, how do you use it? First, take the black shrink-wire tubing that came with the kit and trim it so that it covers the IR LED's from their base to just the tip of the LED. This will prevent "spillover" from reaching the IR detector and improve your reliability. You may need to expand the tubing a bit by using your needle-nosed pliers and pushing the tubing over the closed end of the pliers and opening the pliers, thus, expanding the tubing slightly.

You can adjust how far to the side you want to detect an object by aiming the LED's more or less outward. As you aim them out you will expand a "dead zone" directly in front of the IR detector, but you will get more peripheral vision. I have found that the best setting is about 5 degrees out from straight ahead. Your detection range will be determined by the ambient light conditions around it. In a bright room a detection range of 6 to 12" (15-30cm) is pretty common. In dim lighting this is doubled, is a dark room the robot will spazz out from the infinite IR signal bouncing all over the room! I haven't tested the unit out of doors yet, There didn't seem to be any real reason to… I mount my units such that the LED's are even with the front of the RCX brick when using the tank tread design. Remember, this sensor emits IR at the same frequency as your communication tower from your PC, so make sure that you don't have it on and pointing at the tower or you won't be able to download new code! You must call the sensor a light sensor for it to work. You should use the percentage mode for readings as this gives the best granularity for decision making. The following table shows the various readings and their ranges of readings for left and right detection.

No detection	97 - 100
Right detection	57 - 72
Left detection	15 - 27
Both detection	0 - 1

Your numbers should fall within these ranges. After you have programmed your RCX to read the IRPD correctly, you can use the front panel of the RCX brick to read the values it sees. Press the View button until the readout is pointing at the sensor that you have the IRPD connected to and block the sensor you want to look at. Sometimes it looks as if it is not seeing anything, this is often the case when the unit is started when pointing at a strong light source or in complete darkness, just aim away from the offending light or dark for a moment and the unit will recover. As your batteries get low, the IRPD will start acting flaky, the IR detector requires a certain minimum voltage to operate so this can't be avoided. It will not work well for long if you use NiCd rechargeable batteries, I recommend the Rayovac Renewal Rechargeable Alkaline batteries for best operation and cost benefit. The IRPD can be used with VB programs, NQC programs and even the original Mindstorms programming environment!

Here is a VB program that simply detects when the robot is blocked and turns until its not.

```
PBrickCtrl.BeginOfTask task

    'set input 2 to read touch sensor as percent
       PBrickCtrl.SetSensorType 1, 3
       PBrickCtrl.SetSensorMode 1, 4, 0

     'start endless loop
       PBrickCtrl.Loop 2, 0

    'Check if sensor value > 94
       PBrickCtrl.If 9, 1, 0, 2, 94

    'start robot forward, full power
       PBrickCtrl.SetRwd 0
       PBrickCtrl.SetFwd 2
       PBrickCtrl.SetPower 0, 2, 7
       PBrickCtrl.On 20

    'Sensor sees an obstacle!
       PBrickCtrl.Else

    'Obstacle straight ahead - start reversing rt. Tread to avoid.
       PBrickCtrl.While 9, 1, 1, 2, 5
       PBrickCtrl.Off 20
       PBrickCtrl.SetRwd 2
       PBrickCtrl.On 20
       PBrickCtrl.Wait 2, 20
       PBrickCtrl.EndWhile

       PBrickCtrl.EndIf

    'Back to the beginning
       PBrickCtrl.EndLoop

PBrickCtrl.EndOfTask
```

Here is a basic NQC program to detect left, right, both, neither. It uses the tank tread platform and differential (skid) steering:

```
/* these define the inputs/outputs used */
#define EYE            IN_2
#define LEFT    OUT_C
#define RIGHT   OUT_A

#define NORMAL_SPEED 10
#define TURN_SPEED 5
#define DELAY      20
#define LBOTH 5
#define LNONE 90
#define LLEFT 57
#define LRIGHT 15

int eye;

task main
{
     Sensor(IN_2, IN_CFG(STYPE_LIGHT,  SMODE_PERCENT));
      Fwd(RIGHT+LEFT, NORMAL_SPEED);

      while(true)
      {
            eye = EYE;

            if (eye < LBOTH)
            {
               Rev(LEFT + RIGHT, NORMAL_SPEED);
               Sleep(100);
               //wait(EYE == LNONE);
               Fwd(LEFT,TURN_SPEED);
               Rev(RIGHT,TURN_SPEED);
               Sleep(DELAY);
            }
            else if (eye < LLEFT && eye > LRIGHT)
            {
                  Fwd(LEFT, TURN_SPEED);
                  Rev(RIGHT, TURN_SPEED);
                  Sleep(DELAY);
            //      wait(EYE == LNONE);
            }
           else if  (eye > LLEFT && eye < LNONE)
           {
                  Fwd(RIGHT, TURN_SPEED);
                  Rev(LEFT, TURN_SPEED);
                  Sleep(DELAY);
          //    wait(EYE == LNONE);
           }
            else
               Fwd(RIGHT+LEFT, NORMAL_SPEED);
      }
}
```

For the "techy" types out there, here is the schematic of your RCX IRPD.